

Assessment of Air Quality in the International Space Station (ISS) and Space Shuttle Based on Samples Returned aboard STS-111 (UF2) in June 2002

The toxicological assessments of grab sample canisters (GSCs) and 2 solid sorbent air samplers (SSASs) returned aboard STS-111 are reported. Analytical methods have not changed from earlier reports. Surrogate standard recoveries from the GSCs were 86-106% and 62% to 136 % from the SSASs; 2 tubes with low surrogate recoveries were not reported. Pressure tracking indicated no leaks in the canisters during analysis. Recoveries from lab and trip controls for formaldehyde analyses ranged from 87 to 96%.

The two general criteria used to assess air quality are the total-non-methane-volatile organic hydrocarbons (NMVOCs) and the total T-value (minus the CO₂ and formaldehyde contributions). Because of the inertness of Freon 218 (octafluoropropane, OFP), its contribution to the NMVOC is subtracted and tabulated separately. Control of atmospheric alcohols is important to the water recovery system engineers, hence total alcohols (including acetone) are also shown for each sample. Because formaldehyde is quantified from sorbent badges, its concentration is listed separately. These five indices of air quality are summarized below:

<u>Sample Location</u>	<u>Date</u>	<u>NMVOCs - OFP</u> (mg/m ³)	<u>OFP</u> (mg/m ³)	<u>T Value^a</u> (units)	<u>Alcohols</u> (mg/m ³)	<u>Formaldehyde</u> (mg/m ³)
Lab SSAS	12/27/01	8.5	n/a ^b	0.77	3.2	0.045
SM SSAS	12/27/01	7.6	n/a	0.72	1.9	0.022
Lab SSAS	1/22/02	8.2	n/a	0.69	2.4	0.044
SM SSAS	1/22/02	9.4	n/a	0.92	1.8	0.034
Lab SSAS	2/28/02	7.9	n/a	0.54	3.2	0.046
SM SSAS	2/28/02	10.0	n/a	1.05	1.5	0.033
Lab SSAS	3/27/02	8.6	n/a	0.67	2.6	0.060
SM SSAS	3/27/02	<i>SSAS sample did not pass QA/QC</i>				0.027
Lab GSC	4/24/02	3.6	14	0.24	2.8	0.043
SM GSC		<i>valve left open after sample acquired-no analysis performed</i>				0.031
Lab SSAS	4/24/02	7.0	n/a	0.67	2.0	0.043
SM SSAS	4/24/02	8.9	n/a	0.73	3.5	0.031
Lab SSAS	5/22/02	10.5	n/a	0.80	3.6	0.044
SM SSAS	5/22/02	<i>SSAS sample did not pass QA/QC</i>				0.029
SM GSC	5/23/02	5.6	19	0.66	4.5	0.029
Lab GSC	5/23/02	6.9	16	0.42	4.2	0.044
MPLM 1 GSC	6/08/02	15.0	0.0	1.42	7.5	ns ^c
Shuttle Preflight	6/05/02	0.4	n/a	0.02	0.1	ns
Shuttle Middeck		<i>end of mission sample not collected</i>				
Acceptable Guideline:		<25	85000	<1	<5 ^d	0.050

^a Formaldehyde and CO₂ not included in T calculation.

^b n/a = not in analysis plan for SSAS or preflight samples

^c ns = no sample

^d New guideline based on memo MSFC FD21 (03-012), November 2002 (Perry)

The table shows that the air quality in general was acceptable for crew respiration; however, certain values shown in bold require further explanation. The 1.05 T value on 2/28/02 was caused by an unusually high measurement of hexamethylcyclotrisiloxane (T value = 0.50), which is not a concern. The MPLM T value of 1.42 and the alcohol level of 7.5 mg/m³ were due to an overall polluted atmosphere, which was expected at first entry. The major T-value component was

carbon monoxide at a contribution of 0.44 units. Since the crew was only exposed momentarily to the polluted atmosphere, no health effects are expected. The formaldehyde value of 0.060 mg/m³ found in the Lab sample from 3/27/02 is cause for concern because the Lab consistently shows higher concentrations of formaldehyde than the SM and occasionally the concentrations are above the acceptable guideline.

Levels of OFP have remained low, suggesting that no further leaks of the SM air conditioner have occurred.

Enclosures

- 1A: Analytical Results of STS-111/UF2 GSC Samples
- 1B: Analytical Results of UF2 SSAS
- 2A: T Values of STS-111/UF2 GSC Samples
- 2B: T Values of UF2 SSAS

TABLE 1A
ANALYTICAL RESULTS OF
ISS UF2/STS-111 CONTAINER AIR SAMPLES

TABLE 1A
ANALYTICAL RESULTS OF
ISS UF2/STS-111 CONTAINER AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/m ³)					
	AA03379 SN1068 Lab 04/24/2002 10:03GMT	AA03381 SN1042 Service Mod. 05/23/2002 15:15GMT	AA03382 SN1037 Lab 05/23/2002 15:15GMT	AA03383 SN1008 MPLM 1 06/08/2002 21:20GMT	AA03376 SN1002 Preflight 06/05/2002 12:55EDT	AA03384 SN1006 Trip Control
TARGET COMPOUNDS (TOXIC)						
1,3-BUTADIENE	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
ETHYLENE OXIDE	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
CARBON DISULFIDE	TRACE	TRACE	TRACE	TRACE	<0.05	<0.05
2-METHYL-2-PROPENAL	<0.05	<0.05	<0.05	TRACE	<0.05	<0.05
3-BUTEN-2-ONE	<0.05	TRACE	TRACE	TRACE	<0.05	TRACE
2-ETHOXYETHANOL	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
DIMETHYLDISULFIDE	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
OCTAMETHYLCYCLOTETRASILOXANE	TRACE	TRACE	0.24	0.11	TRACE	0.08
NON-TARGET COMPOUNDS						
OCTAFLUOROPROPANE	14	19	16	0.036	ND	ND
1-PROPENE	0.011	0.015	0.013	0.006	0.001	0.001
CARBONYL SULFIDE	0.001	0.001	0.001	0.057	0.001	BL
TRIMETHYLSILANOL	0.133	0.069	0.125	1.629	0.014	0.007
1,3-DIOXOLANE	0.027	0.013	0.021	0.289	BL	BL
CYCLOHEXANE	0.002	0.003	0.002	0.140	BL	BL
C8-ALKANE	BL	BL	BL	0.019	BL	BL
ACETIC ACID, PROPYL ESTER	BL	BL	BL	0.071	BL	BL
METHYLCYCLOHEXANE	BL	0.001	0.001	0.059	BL	BL
HEXAMETHYLCYCLOTETRASILOXANE	0.100	0.146	0.791	0.700	0.036	0.473
OCTAMETHYLTESISILANE	BL	BL	BL	0.339	BL	BL
C12-ALKANE	0.009	0.015	0.011	0.013	BL	0.009
LIMONENE	0.028	0.081	0.054	0.013	BL	BL
DECAMETHYLCYCLOPENTASILOXANE	0.030	0.030	0.197	0.136	0.033	0.061
TOTAL ALCOHOLS PLUS ACETONE	2.8	4.5	4.2	7.5	0.1	0.1
TARGET COMPOUNDS (GC)***						
ETHYLENE	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
CARBON MONOXIDE	TRACE	TRACE	TRACE	4.80	<1.1	<1.1
METHANE	12.0	18.0	17.0	1.7	1.1	<0.2
HYDROGEN	TRACE	1.6	1.0	<1.6	<1.6	<1.6
CARBON DIOXIDE	7700	7700	11000	480	1300	TRACE
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	17.6	24.6	22.9	15.0	0.4	1.0

<: Value is less than the laboratory report detection limit.

TRACE: Amount detected is sufficient for compound identification only. Calculations are based on one-half of the laboratory report detection limit (1.1 mg/m³ for CO; 0.2 mg/m³ for CH₄; 1.6 mg/m³ for H₂; 0.05 mg/m³ for VOCs; and 0.02 mg/m³ for propenal.)

BL: Area below the search routine limit (<20% of the fluorobenzene peak area).

***Measurements are calibrated by multi-point initial calibration and verified by mid-point continuing calibration.

NOTE: High levels (above 1.5 ppm) of Methanol, Ethanol, Acetone, Isopropanol and 2-Butanone are routinely reported based on calibrated GC-FID measurements.

TABLE 1B
ANALYTICAL RESULTS OF
ISS EXPEDITION 4 SOLID SORBENT AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/m ³)											
	AA03393 LAB SN0011 TUBE 1 12/27/01 @12:02GMT 12/28/01 @12:15GMT	AA03401 SERVICE MODULE SN0013 TUBE 1 12/27/01 @12:06GMT 12/28/01 @12:10GMT	AA03394 LAB SN0011 TUBE 2 01/22/02 @09:06GMT 01/23/02 @09:05GMT	AA03402 SERVICE MODULE SN0013 TUBE 2 01/22/02 @09:08GMT 01/23/02 @09:10GMT	AA03395 LAB SN0011 TUBE 3 02/28/02 @07:37GMT 03/01/02 @14:13GMT	AA03403 SERVICE MODULE SN0013 TUBE 3 02/28/02 @07:39GMT 03/01/02 @14:14GMT	AA03396 LAB SN0011 TUBE 4 03/27/02 @08:25GMT 03/28/02 @08:00GMT	AA03404 SERVICE MODULE SN0013 TUBE 4 03/27/02 @08:30GMT 03/28/02 @08:00GMT	AA03397 LAB SN0011 TUBE 5 04/24/02 @10:04GMT 04/25/02 @14:11GMT	AA03405 SERVICE MODULE SN0013 TUBE 5 04/24/02 @10:09GMT 04/25/02 @14:12GMT	AA03398 LAB SN0011 TUBE 6 05/22/02 @08:28GMT 05/23/02 @10:25GMT	AA03406 SERVICE MODULE SN0013 TUBE 6 05/22/02 @08:20GMT 05/23/02 @10:21GMT
	TARGET COMPOUNDS (TO-14/POLAR)***											
FREON 12	0.03	0.02	0.04	0.05	0.02	0.02	0.02	0.02	TRACE	0.02	0.02	0.02
CHLOROMETHANE	0.02	0.01	0.02	0.04	0.02	0.02	TRACE	TRACE	TRACE	0.01	0.02	0.01
FREON 114	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
METHANOL	0.38	0.21	0.42	0.31	0.61	0.24	0.38	0.35	0.32	0.34	0.39	0.35
ACETALDEHYDE	0.15	0.12	0.11	0.13	0.21	0.14	0.16	0.15	0.11	0.25	0.18	0.20
VINYL CHLORIDE	TRACE	< 0.014	TRACE	TRACE	< 0.011	< 0.018	< 0.015	TRACE	TRACE	TRACE	TRACE	TRACE
BROMOMETHANE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
ETHANOL	1.79	0.94	1.29	0.85	1.93	0.89	1.67	0.89	1.36	2.46	2.68	2.02
CHLOROETHANE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	< 0.013	TRACE	TRACE	TRACE
ACETONITRILE	TRACE	TRACE										
PROPENAL	TRACE	TRACE	TRACE	TRACE	< 0.005	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
ACETONE	0.23	0.19	0.18	0.22	0.17	0.15	0.15	0.11	0.10	0.22	0.17	0.20
PROPANAL	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	0.02	TRACE	TRACE	TRACE	TRACE	TRACE
2-PROPANOL	0.46	0.35	0.25	0.19	0.25	0.09	0.20	0.07	0.10	0.17	0.15	0.14
FREON 11	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	0.01	TRACE	TRACE
FURAN	TRACE	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	TRACE	TRACE	< 0.014	TRACE
ACRYLONITRILE	TRACE	TRACE										
PENTANE	TRACE	TRACE										
2-METHYL-2-PROPANOL	TRACE	TRACE										
METHYL ACETATE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	< 0.018	TRACE	TRACE	< 0.013	TRACE	TRACE
1,1-DICHLOROETHENE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
DICHLOROMETHANE	0.18	0.12	0.21	0.24	0.22	0.14	0.25	0.17	0.10	0.22	0.18	0.18
3-CHLOROPROPENE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
FREON 113	TRACE	TRACE	TRACE	TRACE	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	TRACE	< 0.014	< 0.014
N-PROPANOL	0.14	0.11	0.04	0.04	0.05	0.02	0.03	TRACE	0.02	0.02	0.05	0.03
1,1-DICHLOROETHANE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
BUTANAL	TRACE	TRACE										
2-BUTANONE	0.04	0.03	0.03	0.03	0.02	0.03	0.02	0.02	0.02	0.03	0.03	0.03
CIS-1,2-DICHLOROETHENE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
2-METHYLFURAN	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
ETHYL ACETATE	0.08	0.06	0.06	0.06	0.03	0.04	0.03	0.06	0.02	0.08	0.03	0.06
HEXANE	TRACE	< 0.014	TRACE	< 0.016	< 0.011	< 0.018	< 0.015	TRACE	< 0.013	TRACE	< 0.014	TRACE
CHLOROFORM	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
2-BUTENAL	< 0.015	< 0.014	TRACE	< 0.016	TRACE	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
1,2-DICHLOROETHANE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	0.02	TRACE	TRACE
1,1,1-TRICHLOROETHANE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
N-BUTANOL	0.17	0.13	0.23	0.18	0.19	0.12	0.22	0.13	0.27	0.19	0.25	0.25
BENZENE	TRACE	TRACE										
TETRACHLOROMETHANE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
2-PENTANONE	TRACE	TRACE										
PENTANAL	TRACE	TRACE										
1,2-DICHLOROPROPANE	TRACE	TRACE										
1,4-DIOXANE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	TRACE	TRACE	TRACE	TRACE
TRICHLOROETHENE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
2,5-DIMETHYLFURAN	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
4-METHYL-2-PENTANONE	TRACE	TRACE										
CIS-1,3-DICHLOROPROPENE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
2-PENTENAL	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
TRANS-1,3-DICHLOROPROPENE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
1,1,2-TRICHLOROETHANE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
TOLUENE	0.06	0.05	0.06	0.07	0.04	0.04	0.08	0.71	0.06	0.07	0.10	0.28
HEXANAL	TRACE	TRACE										
MESITYL OXIDE	TRACE	TRACE	TRACE	< 0.016	TRACE	TRACE	TRACE	< 0.017	< 0.013	< 0.013	TRACE	< 0.014
1,2-DIBROMOETHANE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
BUTYL ACETATE	0.02	TRACE	TRACE	0.02	TRACE	0.01	TRACE	TRACE	TRACE	0.02	TRACE	0.02
TETRACHLOROETHENE	TRACE	< 0.014	TRACE	< 0.016	TRACE	< 0.018	< 0.015	< 0.017	< 0.013	TRACE	TRACE	TRACE
CHLOROBENZENE	TRACE	TRACE										
ETHYL BENZENE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	0.02	TRACE	TRACE
META-PARA-XYLENES	0.05	0.05	0.05	0.06	0.04	0.04	0.05	0.04	0.07	0.03	0.08	0.06
2-HEPTANONE	TRACE	TRACE										
CYCLOHEXANONE	0.04	0.04	0.06	0.04	0.05	0.03	0.05	0.03	0.03	0.04	0.06	0.03
HEPTANAL	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	0.02	TRACE	TRACE	TRACE	TRACE	TRACE
STYRENE	TRACE	TRACE										
1,1,2,2-TETRACHLOROETHANE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
ORTHO-XYLENE	0.11	0.12	0.09	0.12	0.06	0.08	0.53	0.72	0.09	0.26	0.09	0.15
1,3,5-TRIMETHYLBENZENE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	TRACE	< 0.013	TRACE	< 0.014	< 0.014
1,2,4-TRIMETHYLBENZENE	TRACE	TRACE										
1,3-DICHLOROBENZENE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
1,4-DICHLOROBENZENE	TRACE	TRACE										
1,2-DICHLOROBENZENE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
1,2,4-TRICHLOROBENZENE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
HEXAACHLORO-1,3-BUTADIENE	< 0.022	< 0.021	< 0.021	< 0.024	< 0.017	< 0.027	< 0.023	< 0.025	< 0.019	< 0.02	< 0.021	< 0.021

CHEMICAL CONTAMINANT	CONCENTRATION (mg/m ³)											
	AA03393 LAB SN0011 TUBE 1 12/27/01 @12:02GMT 12/28/01 @12:15GMT	AA03401 SERVICE MODULE SN0013 TUBE 1 12/27/01 @12:06GMT	AA03394 LAB SN0011 TUBE 2 01/22/02 @09:06GMT 01/23/02 @09:05GMT	AA03402 SERVICE MODULE SN0013 TUBE 2 01/22/02 @09:08GMT 01/23/02 @09:10GMT	AA03395 LAB SN0011 TUBE 3 02/28/02 @07:37GMT 03/01/02 @14:13GMT	AA03403 SERVICE MODULE SN0013 TUBE 3 02/28/02 @07:39GMT 03/01/02 @14:14GMT	AA03396 LAB SN0011 TUBE 4 03/27/02 @08:25GMT 03/28/02 @08:00GMT	AA03404 SERVICE MODULE SN0013 TUBE 4 03/27/02 @08:30GMT 03/28/02 @08:08GMT	AA03397 LAB SN0011 TUBE 5 04/24/02 @10:04GMT 04/25/02 @14:11GMT	AA03405 SERVICE MODULE SN0013 TUBE 5 04/24/02 @10:09GMT 04/25/02 @14:12GMT	AA03398 LAB SN0011 TUBE 6 05/22/02 @08:28GMT 05/23/02 @10:25GMT	AA03406 SERVICE MODULE SN0013 TUBE 6 05/22/02 @08:20GMT 05/23/02 @10:21GMT
TARGET COMPOUNDS (TOXIC)												
1,3-BUTADIENE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
ETHYLENE OXIDE	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
CARBON DISULFIDE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
2-METHYL-2-PROPENAL	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
3-BUTEN-2-ONE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
2-ETHOXYETHANOL	< 0.015	< 0.014	< 0.014	< 0.016	< 0.011	< 0.018	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	< 0.014
DIMETHYLDISULFIDE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	< 0.015	< 0.017	< 0.013	< 0.013	< 0.014	TRACE
OCTAMETHYLCYCLOTETRASILOXANE	1.18	0.77	1.40	1.24	0.73	1.83	1.45	0.97	1.33	0.60	1.27	0.52
NON-TARGET COMPOUNDS												
PROFENE	0.102	0.063	0.064	0.096	0.025	0.034	0.024	0.051	0.013	0.028	0.023	0.034
CARBONYL SULFIDE	0.039	0.029	0.024	0.027	0.021	0.032	0.041	0.038	0.025	0.036	0.029	0.034
PROPANE	0.005	0.004	0.006	0.010	0.003	0.006	0.002	0.006	0.003	0.005	0.005	0.004
2-METHYLPROPANE	0.015	0.010	0.011	0.012	0.010	0.011	0.015	0.015	0.010	0.014	0.018	0.020
C4-ALKENE	0.009	0.005	0.009	0.008	0.008	0.006	0.007	0.008	0.004	0.006	0.005	0.008
TRIMETHYLSILANOL	0.177	0.064	0.209	0.079	0.167	0.059	0.130	0.064	0.117	0.099	0.121	0.097
2-METHYL-2-PROPENENITRILE	0.004	0.002	0.003	0.003	0.002	0.002	0.002	0.002	0.001	0.004	0.002	0.003
1,3-DIOXOLANE	0.025	0.011	0.028	0.016	0.035	0.012	0.035	0.067	0.022	0.018	0.030	0.038
2-METHYL-PROPANENITRILE	0.009	0.006	0.010	0.008	0.006	0.006	0.006	0.009	0.004	0.011	0.005	0.009
CYCLOHEXANE	0.013	0.006	0.009	0.005	0.004	0.003	0.003	0.007	0.002	0.004	0.003	0.006
C7-ALKANE	0.022	0.011	0.015	0.009	0.007	0.005	0.005	0.009	0.003	0.009	0.004	0.008
C7-ALKANE	0.028	0.013	0.019	0.010	0.008	0.007	0.007	0.012	0.004	0.011	0.005	0.010
HEXAMETHYLCYCLOTETRASILOXANE	1.635	3.034	1.656	3.960	1.698	4.564	1.920	1.874	1.735	2.061	3.143	1.787
BENZALDEHYDE	0.013	0.010	0.015	0.017	0.009	0.014	0.015	0.020	0.011	0.014	0.017	0.013
DECANE	0.004	0.002	0.004	0.003	0.002	0.003	0.001	0.018	0.006	0.019	0.009	0.010
C-4 SUBSTITUTED BENZENE	0.009	0.007	0.009	0.010	0.003	0.006	0.003	0.006	0.003	0.007	0.005	0.006
2-ETHYL-1-HEXANOL	0.044	0.024	0.045	0.027	0.043	0.018	0.039	0.051	0.037	0.039	0.076	0.041
LIMONENE	0.011	0.007	0.036	0.042	0.015	0.026	0.017	0.025	0.018	0.055	0.060	0.071
UNDECANE	0.004	0.002	0.003	0.003	0.002	0.002	0.004	0.010	0.005	0.013	0.009	0.009
DECAMETHYLCYCLOPENTASILOXANE	0.349	0.208	0.671	0.424	0.401	0.523	0.298	0.263	0.374	0.448	0.511	0.221
TOTAL ALCOHOLS PLUS ACETONE	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	8.5	7.6	8.2	9.4	7.9	10.0	8.6	7.9	7.0	8.9	10.5	7.8

< : Values are less than the laboratory report detection limit.

TRACE: Amount detected is sufficient for compound identification only. Calculations are based on one-half of the laboratory report detection limit (0.05 mg/m³ for VOCs; and 0.02 mg/m³ for propenal.)

***Measurements are calibrated by multi-point initial calibration and verified by mid-point continuing calibration

TABLE 2A
ANALYTICAL RESULTS OF
ISS UF2/STS111 CONTAINER AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)				T-VALUE (7-d SMAC)	
	AA03379 SN1068 Lab 04/24/2002 10:03GMT	AA03381 SN1042 Service Mod. 05/23/2002 15:15GMT	AA03382 SN1037 Lab 05/23/2002 15:15GMT	AA03383 SN1008 MPLM 1 06/08/2002 21:20GMT	AA03376 SN1002 Preflight 06/05/2002 12:55EDT	AA03384 SN1006 Trip Control
TARGET COMPOUNDS (TO-14/POLAR)***						
FREON 12	0.00005	0.00005	0.00005	ND	ND	ND
CHLOROMETHANE	0.00061	0.00061	0.00061	0.00061	ND	ND
FREON 114	ND	ND	ND	ND	ND	ND
METHANOL	0.05488	0.07744	0.06187	0.07380	0.00278	0.00278
ACETALDEHYDE	0.02617	0.03056	0.02498	0.04153	0.00625	0.00625
VINYL CHLORIDE	ND	ND	ND	ND	ND	ND
BROMOMETHANE	ND	ND	ND	ND	ND	ND
ETHANOL	0.00095	0.00170	0.00166	0.00058	0.00001	0.00001
CHLOROETHANE	ND	ND	ND	ND	ND	ND
ACETONITRILE	0.00373	0.00373	0.00373	0.00373	ND	0.00373
PROPENAL	ND	0.33333	ND	ND	ND	ND
ACETONE	0.00255	0.00292	0.00278	0.03859	0.00048	0.00048
PROPANAL	0.00694	0.00694	0.00694	0.02270	0.00175	0.00175
2-PROPANOL	0.00080	0.00058	0.00055	0.02102	0.00017	0.00017
FREON 11	ND	ND	ND	ND	ND	ND
FURAN	ND	ND	ND	ND	ND	ND
ACRYLONITRILE	0.00893	0.00893	0.00893	ND	ND	ND
PENTANE	ND	ND	ND	0.00004	ND	ND
2-METHYL-2-PROPANOL	0.00021	0.00021	ND	0.00061	ND	ND
METHYL ACETATE	ND	ND	ND	0.00021	ND	ND
1,1-DICHLOROETHENE	ND	ND	ND	ND	ND	ND
DICHLOROMETHANE	0.00907	0.00916	0.01085	0.10453	ND	ND
3-CHLOROPROPENE	ND	ND	ND	ND	ND	ND
FREON 113	ND	ND	ND	0.00006	ND	ND
N-PROPANOL	0.00066	0.00026	0.00026	0.00088	ND	ND
1,1-DICHLOROETHANE	ND	ND	ND	ND	ND	ND
BUTANAL	0.00568	0.00568	0.00568	0.00568	0.00141	0.00141
2-BUTANONE	0.00083	0.00083	0.00083	0.03066	0.00083	0.00083
1,2-DICHLOROETHENE	ND	ND	ND	ND	ND	ND
2-METHYLFURAN	ND	ND	ND	0.19231	ND	ND
ETHYL ACETATE	0.00014	0.00014	0.00014	0.00156	ND	ND
HEXANE	ND	ND	ND	0.00014	ND	ND
CHLOROFORM	ND	ND	ND	0.00500	ND	ND
2-BUTENAL	ND	ND	ND	0.01471	ND	ND
1,2-DICHLOROETHANE	0.02500	0.02500	0.02500	0.02500	ND	ND
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND	ND
N-BUTANOL	0.00344	0.00342	0.00254	0.01159	0.00031	0.00031
BENZENE	ND	ND	ND	0.12500	ND	ND
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND	ND
2-PENTANONE	ND	ND	ND	0.00036	ND	0.00036
PENTANAL	0.00472	0.00472	0.00472	0.00472	0.00118	0.00118
1,2-DICHLOROPROPANE	ND	ND	ND	0.00196	ND	ND
1,4-DIOXANE	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLFURAN	ND	ND	ND	ND	ND	ND
4-METHYL-2-PENTANONE	0.00018	0.00018	0.00018	0.00036	ND	ND
CIS-1,3-DICHLOROPROPENE	ND	ND	ND	ND	ND	ND
2-PENTENAL	ND	ND	ND	ND	ND	ND
TRANS-1,3-DICHLOROPROPENE	ND	ND	ND	ND	ND	ND
1,1,2-TRICHLOROETHANE	ND	ND	ND	ND	ND	ND
TOLUENE	0.00042	0.00042	0.00042	0.00816	ND	ND
HEXANAL	0.00410	0.00410	0.00410	0.00410	0.00102	0.00102
MESITYL OXIDE	ND	ND	ND	ND	ND	ND
1,2-DIBROMOETHANE	ND	ND	ND	ND	ND	ND
BUTYL ACETATE	0.00013	0.00013	0.00013	0.00013	ND	ND
TETRACHLOROETHENE	ND	ND	ND	0.00074	ND	ND
CHLOROBENZENE	ND	ND	ND	ND	ND	ND
ETHYL BENZENE	0.00050	0.00050	0.00050	0.00050	ND	ND
M- + P-XYLENES	0.00011	0.00011	0.00011	0.00011	ND	ND
2-HEPTANONE	ND	ND	0.00109	0.00109	ND	ND
CYCLOHEXANONE	0.00042	0.00042	0.00042	0.00042	ND	ND
HEPTANAL	0.00357	0.00357	0.00357	0.00357	0.00089	0.00089
STYRENE	ND	ND	ND	ND	ND	ND
1,1,2,2-TETRACHLOROETHANE	ND	ND	ND	ND	ND	ND
O-XYLENE	0.00038	0.00044	0.00029	0.00011	ND	ND
1,3,5-TRIMETHYLBENZENE	ND	ND	ND	ND	ND	ND
1,2,4-TRIMETHYLBENZENE	ND	ND	ND	ND	ND	ND
1,3-DICHLOROBENZENE	ND	ND	ND	ND	ND	ND
1,4-DICHLOROBENZENE	ND	ND	ND	ND	ND	ND
1,2-DICHLOROBENZENE	ND	ND	ND	ND	ND	ND
1,2,4-TRICHLOROBENZENE	ND	ND	ND	ND	ND	ND
HEXAACHLORO-1,3-BUTADIENE	ND	ND	ND	ND	ND	ND

TABLE 2A
ANALYTICAL RESULTS OF
ISS UF2/STS111 CONTAINER AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)				T-VALUE (7-d SMAC)	
	AA0379 SN1068 Lab 04/24/2002 10:03GMT	AA0381 SN1042 Service Mod. 05/23/2002 15:15GMT	AA0382 SN1037 Lab 05/23/2002 15:15GMT	AA0383 SN1008 MPPLM 1 06/08/2002 21:20GMT	AA0376 SN1002 Preflight 06/05/2002 12:55EDT	AA0384 SN1006 Trip Control
TARGET COMPOUNDS (TOXIC)						
1,3-BUTADIENE	ND	ND	ND	ND	ND	ND
ETHYLENE OXIDE	ND	ND	ND	ND	ND	ND
CARBON DISULFIDE	0.00156	0.00156	0.00156	0.00156	ND	ND
2-METHYL-2-PROPENAL	ND	ND	ND	0.01471	ND	ND
3-BUTEN-2-ONE	ND	0.05814	0.05814	0.05814	ND	0.05814
2-ETHOXYETHANOL	ND	ND	ND	ND	ND	ND
DIMETHYLDISULFIDE	ND	ND	ND	ND	ND	ND
OCTAMETHYLCYCLOTETRASILOXANE	0.00208	0.00208	0.02021	0.00910	0.00009	0.00030
NON-TARGET COMPOUNDS						
OCTAFLUOROPROPANE	0.00016	0.00022	0.00019	0.00000	ND	ND
1-PROPENE	0.00001	0.00002	0.00001	0.00001	0.00000	0.00000
CARBONYL SULFIDE	0.00012	0.00010	0.00007	0.00473	0.00007	BL
TRIMETHYLSILANOL	0.00360	0.00186	0.00337	0.04402	0.00039	0.00018
1,3-DIOXOLANE	0.00074	0.00035	0.00058	0.00803	BL	BL
CYCLOHEXANE	0.00001	0.00002	0.00001	0.00067	BL	BL
C8-ALKANE	BL	BL	BL	0.00008	BL	BL
ACETIC ACID, PROPYL ESTER	BL	BL	BL	0.00042	BL	BL
METHYLCYCLOHEXANE	BL	0.00002	0.00001	0.00098	BL	BL
HEXAMETHYLCYCLOTRILOXANE	0.01112	0.01617	0.08793	0.07782	0.00040	0.00526
OCTAMETHYLTIRISILANE	BL	BL	BL	0.00847	BL	BL
C12-ALKANE	0.00006	0.00011	0.00008	0.00009	BL	0.00006
LIMONENE	0.00005	0.00014	0.00010	0.00002	BL	BL
DECAMETHYLCYCLOPENTASILOXANE	0.00202	0.00202	0.01314	0.00910	0.00022	0.00040
TARGET COMPOUNDS (GC)***						
ETHYLENE	ND	ND	ND	ND	ND	ND
CARBON MONOXIDE	0.05000	0.05000	0.05000	0.43636	ND	ND
METHANE	0.00316	0.00474	0.00447	0.00045	0.00029	ND
HYDROGEN	0.00235	0.00471	0.00294	ND	ND	ND
CARBON DIOXIDE	0.59231	0.59231	0.84615	0.03692	0.10000	0.00215
TOTAL T-VALUE	0.83453	1.26065	1.26190	1.45853	0.11855	0.08767

ND : Value is less than the laboratory report detection limit

BL: Area below the search routine limit (< 20% of the fluorobenzene peak area).

Note: Number of decimal places in T-Values do not represent significant figures of measurements.

***Measurements are calibrated by multi-point initial calibration and verified by mid-point continuing calibration.

TABLE 2B
ANALYTICAL RESULTS OF
ISS EXPEDITION 4 SOLID SORBENT AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-day SMAC)											
	AA03393 LAB SN0011 TUBE 1 12/27/01 @12:15GMT 12/28/01 @12:15GMT	AA03401 SERVICE MODULE SN0013 TUBE 1 12/27/01 @12:06GMT 12/28/01 @12:10GMT	AA03394 LAB SN0011 TUBE 2 01/22/02 @09:06GMT 01/23/02 @09:05GMT	AA03402 SERVICE MODULE SN0013 TUBE 2 01/22/02 @09:08GMT 01/23/02 @09:10GMT	AA03395 LAB SN0011 TUBE 3 02/28/02 @07:37GMT 03/01/02 @14:13GMT	AA03403 SERVICE MODULE SN0013 TUBE 3 02/28/02 @07:39GMT 03/01/02 @14:14GMT	AA03396 LAB SN0011 TUBE 4 03/27/02 @08:25GMT 03/28/02 @08:00GMT	AA03404 SERVICE MODULE SN0013 TUBE 4 03/27/02 @08:30GMT 03/28/02 @08:00GMT	AA03397 LAB SN0011 TUBE 5 04/24/02 @10:04GMT 04/25/02 @14:11GMT	AA03405 SERVICE MODULE SN0013 TUBE 5 04/24/02 @10:09GMT 04/25/02 @14:12GMT	AA03398 LAB SN0011 TUBE 6 05/22/02 @08:25GMT 05/23/02 @10:21GMT	AA03406 SERVICE MODULE SN0013 TUBE 6 05/22/02 @08:20GMT 05/23/02 @10:21GMT
TARGET COMPOUNDS (TOXIC)												
1,3-BUTADIENE	ND	ND										
ETHYLENE OXIDE	ND	ND										
CARBON DISULFIDE	0.00047	0.00044	0.00044	0.00050	0.00034	0.00056	0.00047	0.00053	0.00041	0.00041	0.00044	0.00044
2-METHYL-2-PROPENAL	0.00441	0.00412	0.00412	0.00471	0.00324	0.00529	0.00441	0.00500	0.00382	0.00382	0.00412	0.00412
3-BUTEN-2-ONE	0.01744	0.01628	0.01628	0.01860	0.01279	0.02093	0.01744	0.01977	0.01512	0.01512	0.01628	0.01628
DIMETHYLDISULFIDE	ND	ND										
2-ETHOXYETHANOL	0.0375	0.03500	0.03500	0.04000	0.02750	0.04500	0.04500	ND	ND	ND	ND	0.03500
OCTAMETHYLCYCLOTETRASILOXANE	0.09822	0.06394	0.11691	0.10293	0.06078	0.15211	0.12083	0.08050	0.11054	0.05021	0.10624	0.04344
NON-TARGET COMPOUNDS												
PROPENE	0.00012	0.00007	0.00007	0.00011	0.00003	0.00004	0.00003	0.00006	0.00002	0.00003	0.00003	0.00004
CARBONYL SULFIDE	0.00328	0.00245	0.00196	0.00227	0.00174	0.00263	0.00345	0.00315	0.00210	0.00297	0.00238	0.00284
PROPANE	0.00001	0.00000	0.00001	0.00001	0.00000	0.00001	0.00000	0.00001	0.00000	0.00001	0.00001	0.00000
2-METHYLPROPANE	0.00006	0.00004	0.00004	0.00005	0.00004	0.00005	0.00006	0.00006	0.00004	0.00006	0.00008	0.00008
C4-ALKENE	0.00004	0.00002	0.00004	0.00003	0.00003	0.00003	0.00003	0.00004	0.00002	0.00003	0.00002	0.00003
TRIMETHYLSILANOL	0.00478	0.00173	0.00566	0.00212	0.00451	0.00159	0.00350	0.00172	0.00316	0.00269	0.00327	0.00261
2-METHYL-2-PROPENENITRILE	0.00727	0.00364	0.00564	0.00455	0.00364	0.00364	0.00345	0.00345	0.00255	0.00782	0.00291	0.00545
1,3-DIOXOLANE	0.00070	0.00032	0.00076	0.00043	0.00097	0.00033	0.00098	0.00187	0.00061	0.00050	0.00084	0.00104
2-METHYL-PROPANENITRILE	0.00126	0.00082	0.00137	0.00105	0.00088	0.00075	0.00079	0.00119	0.00058	0.00148	0.00070	0.00122
CYCLOHEXANE	0.00006	0.00003	0.00004	0.00002	0.00002	0.00001	0.00001	0.00003	0.00001	0.00002	0.00001	0.00003
C7-ALKANE	0.00011	0.00005	0.00008	0.00004	0.00003	0.00003	0.00002	0.00004	0.00002	0.00005	0.00002	0.00004
C7-ALKANE	0.00014	0.00006	0.00009	0.00005	0.00004	0.00003	0.00003	0.00006	0.00002	0.00005	0.00002	0.00005
HEXAMETHYLCYCLOTETRASILOXANE	0.18169	0.33714	0.18398	0.44000	0.18870	0.50714	0.21332	0.20820	0.19280	0.22896	0.34917	0.19859
BENZALDEHYDE	0.00008	0.00006	0.00009	0.00010	0.00005	0.00008	0.00009	0.00011	0.00006	0.00008	0.00010	0.00007
DECANE	0.00002	0.00001	0.00002	0.00001	0.00001	0.00001	0.00000	0.00008	0.00003	0.00008	0.00004	0.00004
C-4-SUBSTITUTED BENZENE	0.00063	0.00049	0.00061	0.00072	0.00022	0.00042	0.00024	0.00044	0.00020	0.00051	0.00035	0.00044
2-ETHYL-1-HEXANOL	0.00084	0.00045	0.00086	0.00051	0.00080	0.00034	0.00073	0.00096	0.00070	0.00074	0.00144	0.00077
LIMONENE	0.00002	0.00001	0.00006	0.00008	0.00003	0.00005	0.00003	0.00004	0.00003	0.00010	0.00011	0.00013
UNDECANE	0.00001	0.00001	0.00001	0.00001	0.00000	0.00001	0.00001	0.00003	0.00001	0.00004	0.00003	0.00003
DECAMETHYLCYCLOPENTASILOXANE	0.02326	0.01386	0.04476	0.02824	0.02675	0.03485	0.01988	0.01750	0.02490	0.02987	0.03407	0.01473
TOTAL T-VALUE	0.76834	0.71617	0.69188	0.91783	0.53720	1.05405	0.67300	0.65263	0.66987	0.72599	0.80243	0.71395

ND : Values are less than the laboratory report detection limit.

***Measurements are calibrated by multi-point initial calibration and verified by mid-point continuing calibration